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VINE PRUNING IN CALIFORNIA

PART II

By FREDERIC T. BIOLETTI

(*Vitis vinifera*)
The source of our cultivated grapes

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VINE PRUNING IN CALIFORNIA

By FREDERIC T. BIOLETTI

THE PRACTICE OF PRUNING

Pruning Systems.—There is a very large number of systems of pruning applied to the vine. These systems differ principally in the form given to the body of the vine, and in the management of the annual growth. Some of the differences depend on variations in the nature of the vines, on the cultural and growing conditions of the district, and on the objects of the grower. Others are unessential and are merely a matter of taste. The best system is that which is most adapted to all the conditions of the particular vineyard. Any system which does not take into account the nature of the vine is defective.

Ideals of Pruning.—Before commencing work, the pruner should form a mental picture of an ideal vine of the form desired. Vines are subject to so many accidents of weather, cultivation, and disease that, even with the greatest care and skill, it may be impossible to obtain a single ideal vine in the vineyard. The ideal vine, however, must exist in the pruner's mind or all his vines will be unnecessarily defective. With this ideal constantly in mind, he is able to take such measures as will as much as possible direct the energies of the vine in the right direction and counteract all contrary influences and thus to make each vine approach as nearly as possible the perfect model.

This mental ideal is particularly necessary in the treatment of young vines. Only when it is strongly impressed on the imagination, is it possible to use such means and measures as will most rapidly and economically bring the vine to profitable maturity.

In the following account of the principal systems of pruning adapted to Californian conditions, a description is first given of an ideal mature vine in full bearing. This is followed by a discussion of methods of handling a young vine to make it approach as nearly as possible this ideal, and finally by an account of the regular pruning necessary to make the vine produce maximum crops to a respectable old age.

Californian Systems.—The systems of pruning in use in California may be divided into two classes according to the arrangement of the arms on the trunk of the vine. In the commonest systems, there is a definite head to the trunk, from which all the arms arise symmetrically at nearly the same level. The

vines of these systems may be called "headed vines." In the other systems, the trunk is elongated four to eight feet and the arms are distributed regularly along the whole or the greater portion of its length. The vines of these systems, owing to the rope-like form of the trunks, are called "cordons."

The headed vines are divided according to the length of the vertical trunk into high, 2–3 feet, medium, 1–1½ feet, and low, 0–6 inches. The cordons may be vertical or horizontal, according to the direction of the trunk, which is from four to eight feet long. The horizontal cordons may be single (unilateral) or composed of two branches extending in opposite directions (bilateral). Double and even multiple vertical cordons occur, but they are very inadvisable and have no advantages.

The arrangement of the arms of a headed vine may be symmetrical in all directions at an angle of about 45 degrees. Such a vine is said to be "vase-formed," though the hollow center which this term implies is not essential. This is the form used in the great majority of our vineyards whether of wine, raisin, or shipping grapes. It is suitable for the "square" system of planting and cross cultivation. Where vines are planted in the avenue system, particularly when trellised and where cross cultivation is impossible, the arms are given a "fan-shaped" arrangement in a vertical plane. This arrangement is essential for the economical working of trellised vines.

On the vertical or upright cordon, the arms are arranged at as regular intervals as possible on all sides of the trunk from the top to within twelve or fifteen inches of the bottom. On the horizontal cordon the arms are arranged similarly, but as nearly as possible on the upper side of the trunk only.

Each of these systems may again be divided into two sub-systems, according to the management of the annual growth or canes. In one, spurs of one, two, or three eyes are left for fruit production. This system is called *short* or *spur* pruning. In the other, long canes are left for fruit production. This is called *long* or *cane* pruning. In rare cases an intermediate form is adopted in which long spurs or short canes of five or six eyes are left. In cane pruning, each fruit cane is accompanied by one or two short renewal spurs. These must also accompany half-long pruning. Systems of pruning, where only long canes are left without renewal spurs, are not in use in California. In all systems, replacing spurs are left wherever and whenever needed.

Other modifications are introduced by the manner of disposal of the fruit canes. These may be tied up vertically to a stake driven at the foot of each vine or bowed in a circle and tied to this same stake, or they may be tied laterally to wires stretching along the rows in a horizontal, ascending or descending direction.

The different systems differ therefore in: (1) the shape, length, and direction of the trunk; (2) the arrangement of the arms; (3) the use of fruit spurs or fruit canes with renewal spurs; (4) the disposal of the fruit canes.

The principal possibilities are shown in the following table:

A. Head Pruning: Vase-Form

1. High trunk:
2. Medium trunk:
3. Low trunk:

with
- (*a*) Fruit spurs or
- (*b*) Half-long canes and renewal spurs or
- (*c*) Fruit canes and renewal spurs; canes vertical or bowed.

B. HEAD PRUNING: FAN-SHAPED; TRELLISED

1. High trunk: Fruit canes and renewal spurs; canes descending.
2. Medium trunk: Fruit canes and renewal spurs; canes horizontal or ascending.

C. CORDON PRUNING

1. Vertical: Spur; half-long; cane.
2. Horizontal-unilateral: Spur; half-long; cane.
3. Horizontal-bilateral: Spur; half-long; cane.

All possible combinations indicated by this table represent 24 variations. Some of these combinations, however, are not used and some are rare. The most common are shown in figures 21, 22, 23, 24, and 25.

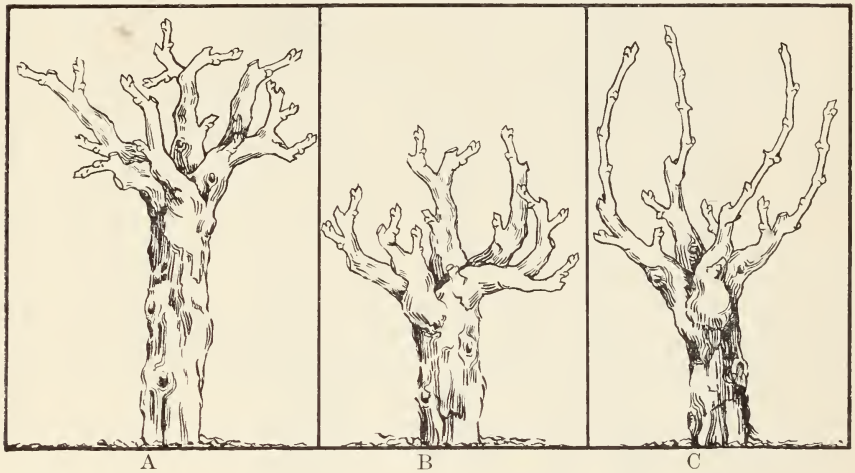


Fig. 21—Forms of head pruning: A, spur pruning with high trunk; B, spur pruning with medium trunk; C, half-long with medium trunk.

Figure 21 B represents a headed, vase-formed vine, with a medium trunk and short fruit spurs. This is the most common system used in all parts of California and is suited for all small growing vines which bear on the lower buds, for most wine grapes and for Muscats. The unit of pruning in this case is a fruit spur of 1, 2, or 3 internodes, according to the vigor of the variety and of the individual cane.

Figure 21 A differs from 21 B only in the higher trunk and longer arms. It is commonly used for Tokay and other large growing varieties, especially when growing in rich soil and when planted far apart.

Figure 21 C has the same form of body as A and B, except that the arms are somewhat less numerous. The unit of pruning is a short fruit cane of four to five internodes, accompanied by a renewal spur of one internode. It is suited for vigorous table grapes, which do not bear well on short spurs. It is used especially for the Cornichon and Malaga in rich soil. This is a difficult system to keep in good shape owing to the tendency for all the vigor to go to the growth on the ends of the friut canes. It is difficult to obtain vigorous canes on the renewal spurs. Occasional short pruning is usually necessary to keep the vines in proper shape.

Figure 22 A is similar to 21 C in form, but the number of arms is still further reduced to 2, 3, or at most 4. The unit of pruning is a fruit cane of 2½ to 3½ feet with its renewal spur. Owing to the length of the fruit canes they require support and are tied to a high stake.

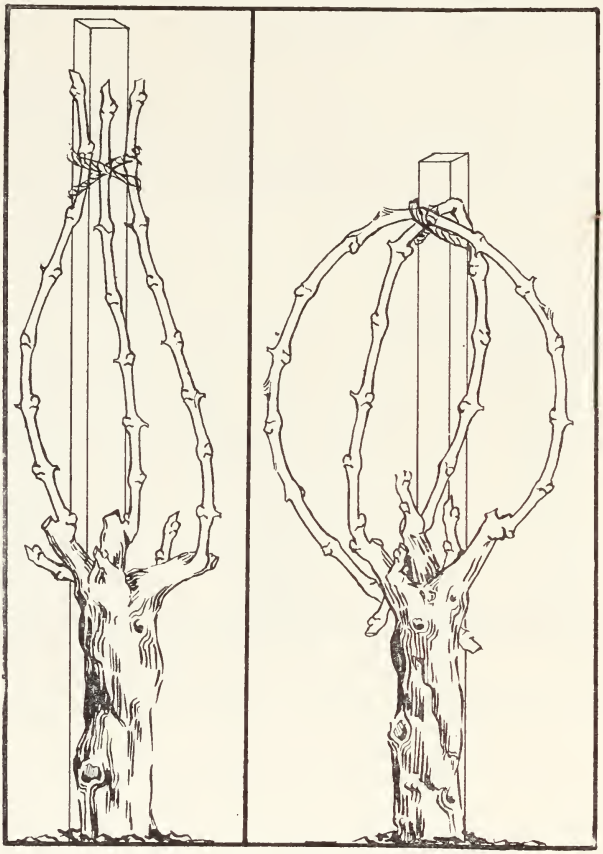


Fig. 22—Forms of head pruning: A, vertical fruit canes and renewal spurs; B, bowed fruit canes and renewal spurs.

This method is used in a large number of vineyards with Sultanina, Sultana and certain wine grapes, especially Semillon and Cabernet. It is not to be recommended in any case, as it has several very serious defects.

The difficulty of obtaining new wood from the renewal spurs is even greater than in the system shown in figure 21 C. The length and vertical position of the fruit canes cause the main growth and vigor of the vine to be expended on the highest shoots. (See Physiological Principles 5 and 6, p. 23, pt. I). The renewal

spurs are thus so shaded that, even though their buds start, the shoots make but a weak growth. The result is that at the following pruning all the good new wood is at the top of the fruit canes of the previous year, where it cannot be utilized. The pruner has to choose then between reverting to spur pruning and getting no crop or using the weak growth from the renewal spurs for fruit canes, in which case he may get blossoms but little or no fruit of any value.

Other defects of this method are that the fruiting shoots are excessively vigorous and therefore often tend to drop their blossoms without setting and the fruit when produced is massed together so that it ripens unevenly and is difficult to gather. It also requires a tall and expensive stake.

Figure 22 B represents an improvement on the last system. It differs only in the method of treating the fruit canes. These are bent over in the form of a circle and tied by their middle part to a stake which may be smaller and lower than that needed for the vertical canes.

This bowing of the canes has several useful effects. The change of direction moderates the tendency of the vigor of the vine to expend itself only on the terminal shoots. More shoots therefore are formed on the fruit canes and as their vigor is somewhat decreased they tend to be more fruitful. The slight mechanical injury caused by the bending operates in the same direction. (See Physiological Principle 4, p. 22, pt. I.)

The excess of vigor thus being diverted from the fruit canes causes the renewal spurs to form vigorous shoots, which soon grow above the fruit shoots and obtain the light and air they need for their proper development. This method is used successfully for certain wine grapes such as Riesling, Cabernet, and Semillon. It is unsuited to large vigorous varieties or for vines on rich soil planted wide apart. In these cases two fruit canes are usually insufficient and, if more are used, the grapes and leaves are so massed together that they are subject to mildew and do not ripen evenly or well. The bowing and tying of the canes requires considerable skill and care on the part of the workmen.

The body, arms, and annual pruning of the system shown in figure 23 are similar to those of figure 22, with the exception that the arms are given a fan-shaped arrangement in one plane. It differs in the disposal of the fruit canes, which are supported by a trellis stretching along the row from vine to vine.

This method is largely used for the Sultanina (Thompson's Seedless), and is the best system for vigorous vines which require long pruning, wherever it is possible to dispense with cross cultivation. It is also suitable for any long-pruned varieties when growing in very fertile soil.

Figure 24 is a photograph of a four-year-old Emperor vine, illustrating the vertical cordon system. It consists of an upright trunk 4½ feet high with short arms and fruit spurs scattered evenly and symmetrically from the top to within fifteen inches of the bottom. This system is used in many Emperor vineyards in the San Joaquin Valley.

Its advantages are that it allows the large development of the vine and the large number of spurs which the vigor of the Emperor demands, without, on the one hand, crowding the fruit by the proximity of the spurs or, on the other hand, spreading the vine so much that cultivation is interfered with. It also permits cross cultivation.

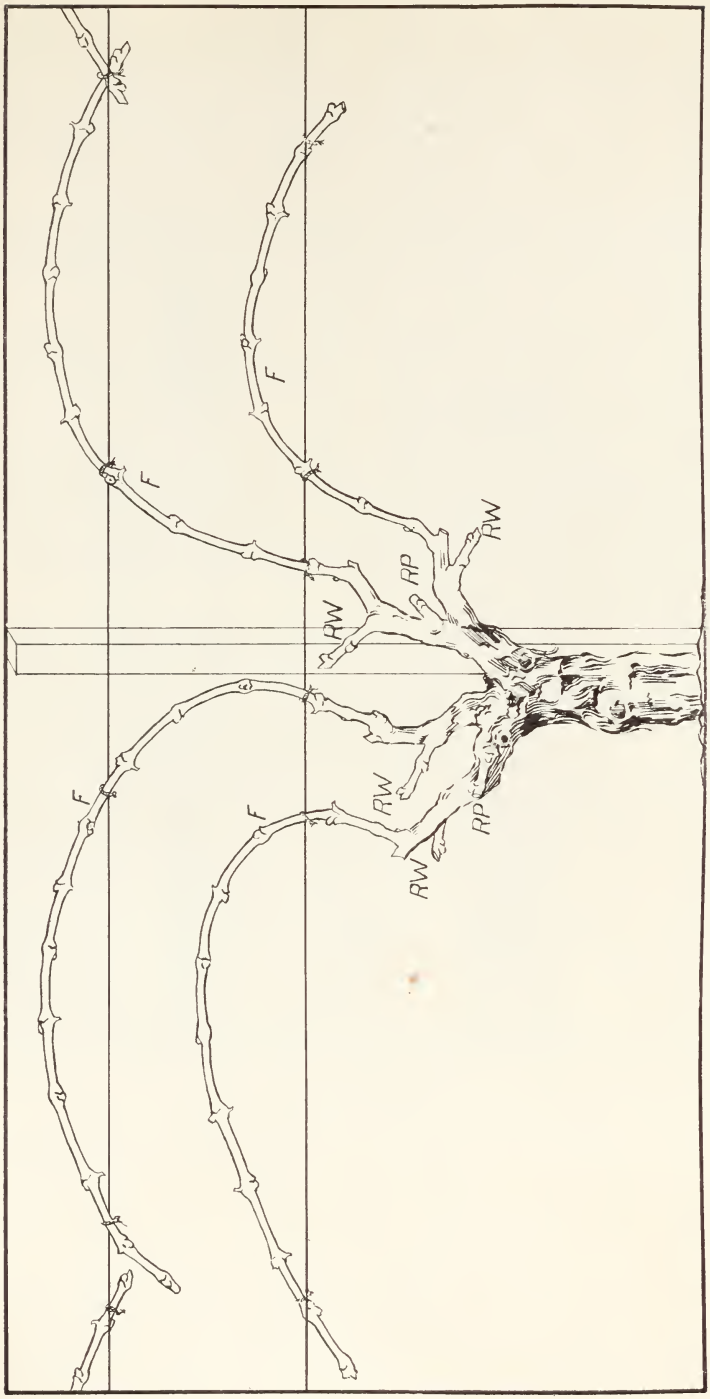


Fig. 23.—Head pruning: fan-shaped head; fruit canes tied to horizontal trellis.

One of its defects is that the fruit is subjected to various degrees of temperature and shading in different parts of the vine and the ripening and coloring are often uneven. A more vital defect is that it cannot be maintained permanently. The arms and spurs at the top of the trunk tend to absorb the energies of the vine and the lower arms and spurs become weaker each year until finally no growth at all is obtained below. After several years, most of the vines therefore lose their character of cordons and become simply headed-vines with abnormally long trunks. (See figs. 61, 62.)

The cordon can be re-established in this case by allowing a vigorous sucker to develop one year from which to form a new trunk the next. The following year the old trunk is removed entirely. An objection to this method is that it makes very large wounds in the most vital part of the vine—the base of the trunk.

Figure 25 is a photograph of a four-year-old Colombar vine, illustrating the unilateral, horizontal cordon system. It consists of a trunk about seven feet long, supported horizontally by a wire two feet from the ground. Arms and spurs are arranged along the whole horizontal part of the trunk

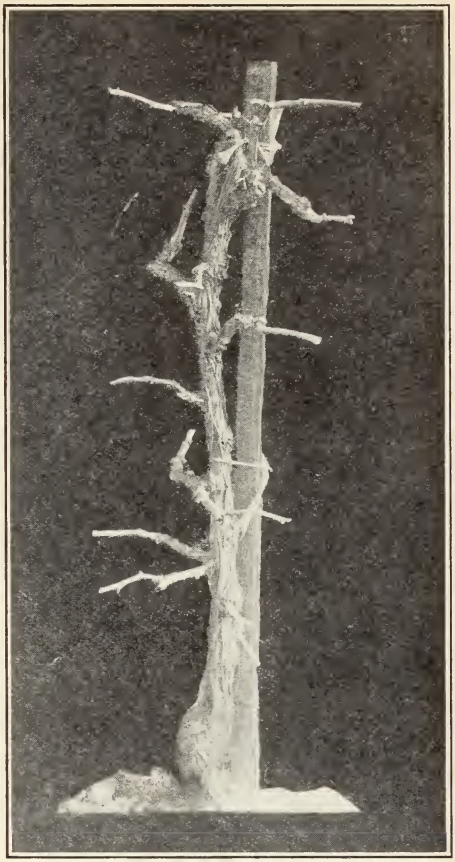


Fig. 24—Single vertical cordon with fruit spurs.

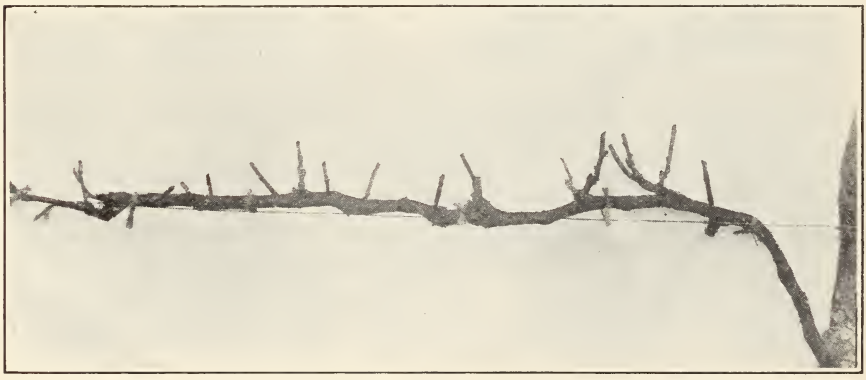


Fig. 25—Unilateral horizontal cordon with fruit spurs.

Figure 25 is a photograph of a four-year-old Colombar vine, illustrating the unilateral, horizontal cordon system. It consists of a trunk about seven feet long, supported horizontally by a wire two feet from the ground. Arms and spurs are arranged along the whole horizontal part of the trunk.

This system accomplishes the same objects as the vertical cordon. It allows a large development of the vine and numerous fruit spurs without crowding. It is superior to the vertical cordon in the distribution of the fruit, which is all exposed to approximately the same conditions owing to the uniform distance from the ground of the fruit spurs. All parts of the trunk producing an annual growth of wood and fruit are equally exposed to light and the tendency of the growth to occur principally at the part of the trunk farthest removed from the root is counteracted by the horizontal position. There is not the same difficulty therefore in maintaining this form of vine permanently that there is with the vertical cordon.

This system should not be used for small weak vines, whether the weakness is a characteristic of the variety or due to the nature of the soil. It is suited only to very vigorous varieties such as Emperor, Almeria, and the Persian grapes when growing far apart in rich, moist soil.

Periods of Development.—The first year in the life of a vine is devoted to developing a vigorous root system; the next two or three years to building up a shapely trunk and head, and a like period to forming the full complement of arms. At the end of from five to nine years the framework of the vine is complete and should undergo no particular change of shape except a gradual thickening of trunk and arms.

There are, therefore, several periods in the life of the vine with varying objects, and the methods of pruning must vary accordingly. These periods do not correspond exactly to periods of time, so it may be misleading to speak of pruning a two-year-old[1] or a three-year-old vine. One vine under certain conditions will reach the same stage of development in two years that another will reach only in three or four years under other conditions. The range of time of these periods is about as follows:

First period—Formation of a strong root system	1 to 2 years
Second period—Formation of stem or trunk	1 year
Third period—Formation of head	2 to 3 years
Fourth period—Complete development of the arms	2 to 3 years
Total time of formation of framework	6 to 9 years

Under exceptionally favorable conditions the first and second periods may be included in the first year and a completely formed vine may be obtained in five years.

Before Planting.—For planting, cuttings, one-year-old rooted vines, or bench grafts are used. In all cases, they need some attention from the pruner. In figure 26 are shown the three forms of cuttings used

[1] *Age of Vines.*—There is a diversity of usage in denoting the age of a vine. In some sections, a one-year-old vine means a vine that is in its first year. In others, it means a vine that has completed its first year and is in its second. The former method is adopted here as the most convenient.

in California. They differ only in length. The shortest, eight to ten inches, are best suited for planting in the nursery; those of twelve to fourteen inches for planting in the field in most cases. The longer cuttings, sixteen to eighteen inches, are to be recommended only in the driest soils. In all cases they are cut at the bottom just below a bud. This facilitates the healing over of the base, as roots and healing tissue form most abundantly near a node. The top may be cut just above a bud, so as to leave the protecting diaphragm or about one inch of internode left, as in the figure.

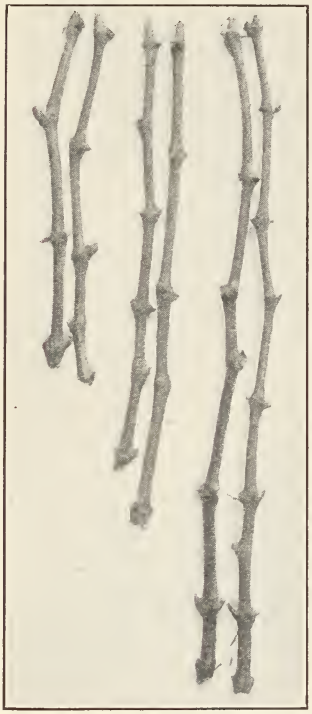


Fig. 26—Forms of cuttings.

Fig. 27—One-year-old rooted vines.

Figure 27 shows a bundle of good one-year-old rooted vines as they are usually prepared at the nursery. Before planting they must be pruned. The method of pruning depends on the size and shape of the vine and on the method of planting adopted.

Figure 28 shows a good rooted vine of average size having a single cane at the top and several good roots at the bottom. The usual way to prune this is to shorten the cane to one or two buds and the roots to two or four inches, according to their size. Shortening the cane

makes the vine less liable to dry out before rooting and forces the growth from the lower buds which produce more vigorous shoots. The roots are shortened so that there will be no danger of the ends being turned upwards when planted. If they are to be planted in a large hole they may be left as long as five or six inches; if to be planted with a crowbar or dibble, they must be cut back to half an inch.

Fig. 28—Rooted vine with single cane.

Fig. 29—Rooted vine with two canes.

There is little if any advantage in leaving long pieces of roots. They are not feeding roots and are of no use to the vine until they develop feeding rootlets. This they will do as well or better if shortened as if left of full length. The main advantage of a rooted vine over a cutting is that it forms rootlets more easily and rapidly. There may be a slight advantage in leaving three or four inches of the sound well-grown roots, as the reserve matters they contain probably promote a better growth of rootlets, but little or no difference has been noted between the growth of vines of which the roots have been shortened to one-half inch and those which have been left longer.

Where the roots are left long, moreover, more care and time are needed in planting.

If the rooted vine has several canes, all but one should be removed entirely, and this one shortened to one or two eyes. The one left should be that which is strongest, has the best buds, and is the best placed. Figure 29 shows the removal of a cane growing horizontally and two buds left on a vertical cane. Where a horizontal cane is left,

Fig. 30—Rooted vine with canes at two levels.

Fig. 31—Rooted vine pruned ready for planting.

it should be cut back to the base bud. Otherwise the main growth may occur at a higher bud and the vine will have a crook which will result in a badly formed trunk.

If canes are growing from different joints as in figure 30, it is usually best to leave the lower cane if they are equally vigorous. This brings the buds from which growth will come nearer to the roots, and leaves less of the original cutting, which are advantages. The upper joint between the canes is, moreover, often more or less decayed or imperfect.

Figure 31 shows a vine pruned and ready for planting. Bench grafted vines are pruned in exactly the same way, but in this case it is necessary to take great care that all roots from near or above the union and all canes from near or below the union are removed.

Figure 32 shows a vine grown in the nursery from an unnecessarily long cutting. It was grown in warm, well-drained soil, so that roots have formed at three levels from different nodes. Even in this soil, however, the conditions were not favorable for root growth at the bottom, so the last two nodes have formed no roots. If the cutting

Fig. 32—Nursery vine with roots at different levels.

Fig. 33—Result of planting too deep.

had been of five nodes instead of eight it would have made a much better vine. The roots would have been less numerous, but more vigorous. Such a vine can be pruned in one of three ways, according to the character of the ground in which it is to be planted. In any case, the bottom two joints, without good roots, are cut off. If the soil where the vine is to be planted is deep and dry, the roots at the next three joints may be left and shortened to about one inch, as indicated in the figure. The roots are so numerous that none of them have grown large (see Physiological Principles, p. 23, pt. I), and nothing would be gained by leaving them longer. For ordinary soils

it would be better to remove the lower three joints and for wet soils the lower five.

Figure 33 shows the result of planting an unnecessarily long cutting or rooted vine. It represents the lower part of the under-ground portion of a vine two or three years old. The cutting or rooted vine was at least three joints too long, and the lowest part not only furnishes no roots of any value but is liable to decay, which may spread into the rest of the vine.

Fig. 34—Roots of a young vine that had been properly pruned before planting.

Figure 34 shows the root growth during the first year in the field of a rooted vine of which the roots had been properly pruned and planted at the right depth.

Planting.—Cuttings made as directed are planted with the second bud at the level of the ground, leaving only one bud above. Rooted vines are planted with the two buds just above the surface. Bench grafts are planted with the union just one inch above the surface. In the last case the soil must be hilled up so as to cover the union.

First Growing Season.—The treatment during the first spring and summer will depend on what growth the vines are expected to make and on whether the vines are staked the first year.

With cuttings and with both rooted vines and grafts where the growth will be moderate, staking the first year is unnecessary, though it has some slight advantages. In these cases, no pruning of any kind is necessary until the winter following the planting, except in the case of bench grafts. The pruning in the last case is confined to the removal of the suckers from the stock and roots from the scion. If the stocks have been well disbudded by the nurseryman, few suckers will develop. In moist soil, the scion roots may develop vigorously and must be removed before they grow too large, or they may prevent the proper development of the resistant roots.

The removal of roots should usually be done some time in July. For this purpose the hill of soil is scraped away from the union and after the scion roots and suckers are removed it is replaced. In this second hilling up, the union should be just barely covered so that the soil around the union will be dry and unfavorable to a second growth of roots. Later in the season, about September, the soil should be removed entirely from around the union and any new roots that may have formed removed. The union is then left exposed to harden and mature, so that it will pass the winter without injury.

Figure 35 shows a grafted vine in July after the union has been uncovered for root-cutting. It represents a good average vine at this period. Such a vine will usually support itself without a stake, but if a stake is used it should be tied to it loosely. If the main shoot is kept upright it will be easier to produce a well formed vine.

No disbudding, thinning of shoots, or topping need be done in this case. The object is to have as abundant a growth of foliage as possible in order to stimulate a vigorous and abundant root development. (See Physiological Principle No. 1, p. 22, pt. I.)

In some cases, where very good rooted vines of vigorous varieties are planted in rich soil abundantly supplied with water, it is desirable to disbud the vine early in order to throw all its energies into the single main cane. In such cases staking before or just after planting are necessary, and methods similar to those described for the second season are used.

First Winter Pruning.—At the end of the first growing season, an average good vine will have produced from three to five canes, the longest of which will be from two to three feet long.

Soon after the leaves have fallen in December or early in January the vines should be pruned. The method is precisely similar to that used for rooted vines before planting except that the main roots are not touched. All the canes are removed entirely except one. This one should be well matured, at least at the base, and should have well

formed eyes. It is shortened to two eyes. It is well also to cut off all shallow roots within three or four inches of the surface. This is necessary in the case of grafted vines if any have escaped the summer root-cutting.

Fig. 35—Growth of vine during the first summer.

Some of the vines may have made an exceptionally large growth. Such vines may sometimes possess a cane large enough from which to start the trunk in the way described later for the second winter pruning.

Staking.—If the vines have not been staked before, the stakes should be driven soon after pruning and before the starting of the buds.

In order to preserve the alignment of the vineyard, the stakes should be driven on the same side of every vine at a uniform distance. The best distance is about two inches. If driven closer they may injure large roots or even the main underground stem if the vines have not been carefully planted vertically or slanting towards the side on which the stake is to be placed.

The side on which the stake should be placed depends on the direction of the prevailing winds during the growing season. This side is the leeward. That is, the stake should be so placed that the wind will press the vine *towards* the stake instead of *away from* it. This will much facilitate the work of keeping the vine upright and attached to the stake. If the vine is on the other side the pressure of the wind will stretch the string tight and the swaying of the vine will gradually wear the string until it breaks, necessitating retying. By carefully observing this rule, very few vines will require retying even if weak material like binding twine is used.

Second Summer Pruning.—Before the starting of the buds, in the spring following the planting, most of the vines appear about the same as when they were planted. There is, however, a very notable difference, in that they have well developed root systems in the soil where they were formed. The result is that they make a much more prompt and early start and will produce a much larger growth than they did the first season. For this reason they require very careful attention from the pruner during the spring and summer of the second season. Vines neglected at this time, in this respect, may make as large a growth, but a large part of it will be wasted, the vines will be misformed and it will require from one to two years longer to develop a suitable framework and to bring them into bearing, even though they are properly handled during subsequent years. The more vigorous the vines, the more necessary it is to handle them properly during this period.

The main object during this second growing season is to develop a single, strong, vigorous and well ripened cane from which to form the permanent trunk of the vine.

This is done by concentrating all the energies of the vine into the growth of a single shoot. As soon as the buds start, or when the most precocious has developed a shoot of a few inches in length, the vines should be disbudded. This consists in rubbing off with the hand all buds and shoots except the two largest and best placed. The lowest, upright shoots are usually the best. Leave only those which will make a straight vine. It is better to leave less developed buds than a shoot

which, when it grows, will make an awkward crook with the underground stem.

After this disbudding, the two shoots left will grow rapidly, as they receive all the energies of the root system. When the longest have grown from ten to fifteen inches, they should be tied to the stake. Unless this is done, they are liable to be broken off by any heavy wind, owing to their soft, succulent texture. Only the best placed and most vigorous of the two shoots should be tied up. If this shoot is growing upright and near the stake, this can be done without any danger of injuring it. In this case the second shoot should be removed. If the shoot has to be bent over in tying it to the stake it may be injured. In such a case the second shoot should be allowed to grow until it is known whether the first has been injured. In case of injury the second shoot can be tied up the next time the vines are visited and the injured shoot removed.

At the tying up of the reserved shoots, all new shoots which have developed since the first disbudding should be removed. The shoots should be tied up loosely, as they are soft and easily injured, and they should be brought around carefully to the windward side of the stake.

The shoots will require tying once more when they have grown another foot or eighteen inches. There will then be two ties, one at two or three inches from the top of the stake and the other at about the middle. If the vines have a tall stake and are to be headed very high, another tying higher up may be needed later.

With vines making only a moderate growth, no other pruning will be needed until the winter. Exceptionally vigorous vines, however, may make a cane eight, ten or more feet long. Such a cane is heavy and is very likely to break the ropes by which it is attached to the stake. In this case it may break off at the bottom, or at least will form an awkward crook near the ground when it matures. In either case it is difficult to form a good trunk the following year. Even when the ties do not break, the cane will not be well suited for the commencement of a trunk, as the joints will be so long that it will be impossible to leave enough well placed buds at the winter pruning.

Both these difficulties are avoided by timely topping. When such vigorously growing canes have grown twelve or eighteen inches above the top of the stake they are cut back about level with the stake. This is most conveniently done with a long-bladed knife or piece of split bamboo. After topping, the cane ceases to grow in length and laterals start at most of the joints. It is less exposed to the action of the wind and the laterals supply the buds needed for forming the vine at the winter pruning.

The result of the second season's growth, then, has been to produce a single vigorous cane with or without laterals. This is the cane which is to develop into the final and permanent trunk of the vine. It must not only be large and vigorous, but must be properly matured. If the vine is allowed to grow too late in the season, an early frost may destroy the unmatured cane and much of the results of the year's growth will be wasted. Such a frost may indeed kill the entire vine. Grafted vines are particularly liable to injury from this cause, as if they are killed down to the union they are completely ruined. Ungrafted vines when killed to the ground may be renewed from a sucker next year. This sucker, however, is likely to grow with such vigor that it is even more liable to injury from an autumn frost than the original shoot.

This late growth is much more likely to occur with young vines than with old. The old vines stop growing earlier because their energies are directed into the crop, and as they produce a larger amount of foliage they draw more upon the moisture of the soil, which therefore dries out earlier.

Late growth of the young vines must be prevented and the wood matured before frost if possible. This is accomplished by means which promote the drying of the soil in autumn. Late irrigations should be avoided. Cultivation should usually stop by mid-summer. In very moist, rich soils, it is often an advantage to grow corn, sunflowers or similar crops between the rows of vines to take off the surplus moisture. In some cases it is good practice to let the summer weeds grow for the same purpose.

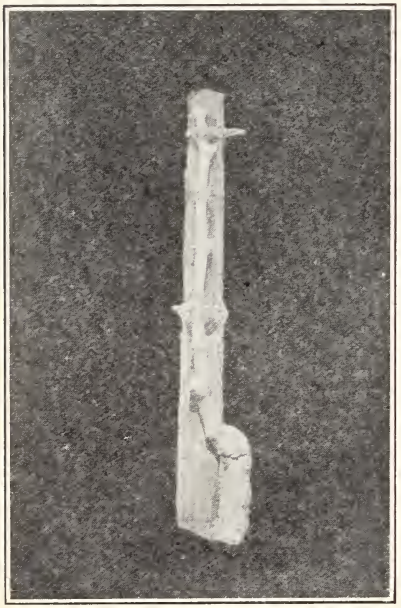


Fig. 36—Second winter pruning, for head of medium height.

Second Winter Pruning.—With vines which have been treated as described and to which no accident has happened, the second winter pruning is very simple. It consists simply in cutting back the single cane which has been allowed to grow to the height at which it is desired to head the vine.

Figure 36 represents a vine which has been cut back to form a

low medium head. It consists of a single cane which with the older wood at the base reaches nearly to the top of the stake, or fifteen inches. This if properly treated will develop into a vine with a trunk of about twelve inches, though this length can be modified slightly, as will be explained later.

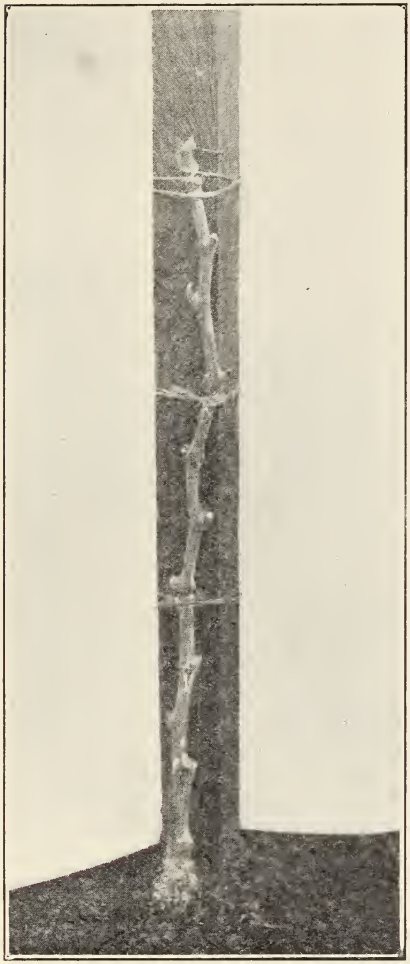


Fig. 37—Second winter pruning, for high head.

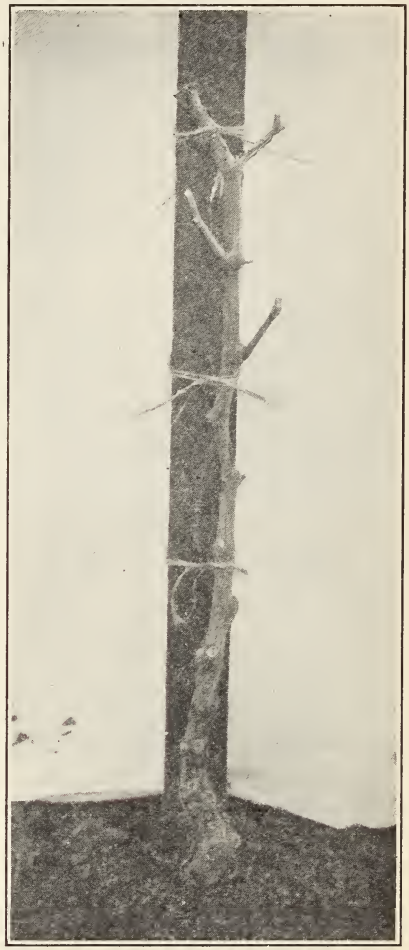


Fig. 38—Second winter pruning of very vigorous vine.

This cane consists of about seven or eight joints or internodes, with an equal number of well formed eyes and an indefinite number of dormant buds, principally near the base of the cane or junction of the one- and two-year-old wood. Only the buds on the upper half of this cane will be allowed to grow. These buds—about four—should

give six to eight bunches of grapes and four, six, or eight shoots from which to form the spurs at the following winter pruning.

Figure 37 represents a vine which has been cut back to form a high head. The cane is about twenty-four inches long and can be used to form a trunk eighteen inches high, though this height can be modified as in the last case. As with the shorter cane, only the buds on the upper half will be allowed to produce shoots. These—about six—should give ten to twelve bunches and the shoots necessary for the formation of spurs.

Figure 38 represents a vigorous vine which had been topped during the summer, and consequently had formed well developed laterals. This vine has been cut back to the same length as that shown in figure 37. One bud has been left of each lateral, giving thus three more buds to produce grapes and shoots.

In all cases a full internode has been left above the top bud. This is done by cutting through the first bud above the highest which it is desired to have grow. This cut is made in such a way as to destroy the bud but to leave the diaphragm intact and part of the swelling of the node. This upper internode is left partly to protect the upper bud, but principally to facilitate tying. By making a half-hitch around this internode, the vine is held very firmly. If the swelling at the node of the destroyed bud is not left, many vines will be pulled out of the hitch when they become heavy with leaves and supple with the flow of sap in the spring.

In tying the vines, no turns or hitches must be made around any part except this upper internode. A hitch below the top bud will result in a crook-necked vine, as the top will bend over in the summer under the weight of the foliage. A hitch lower down is even more harmful, as it will girdle and strangle the vine.

A second tie about half way from the upper to the ground is always necessary to straighten the cane. Even if the cane is straight when pruned, a second tie is needed to keep it from curving under the pressure of leaves and wind in the spring. For high headed vines three ties are usually necessary placed, as shown in figures 37 and 38.

For the top tie, wire is particularly suitable. It holds better than twine and does not wear. Even though it is not removed, it does no harm, as the part around which it is wound does not grow. The lower ties should be of softer material, as wire has a tendency to cut into the wood. They should be placed so that the cane is able to expand as it grows. With thin and especially with round stakes this means that the tie must be loose. With large, square stakes there is usually sufficient room for expansion, even when the twine is tied tight.

However careful the pruner, many of the vines cannot be pruned quite so simply as those described. These methods therefore must often be modified, keeping these vines in mind as ideals which the imperfect vines are made to approach as nearly as may be.

Some of the vines may not make a sufficient growth of cane to be tied up in the way indicated. Such vines should be pruned back again to two buds, as at the previous winter pruning, and special care taken during the following summer to develop a good cane. Vines in which the development of the tying-up cane is thus delayed a year will usually make a very vigorous growth the following summer and must be topped. The result at the following winter pruning will be a vigorous cane with laterals, which should be pruned like the vine in figure 38. All vines which have not made a growth of well developed, mature cane of the length desired should be cut back to two buds. This length will usually be at least twice that of the desired height of trunk because the upper part of the cane is usually badly matured and with imperfect buds. It is bad practice to cut canes to intermediate lengths, as this results usually in crooked trunks and inevitably to variations in the height of the heads of different vines.

If the suckering, disbudding and thinning of shoots have been neglected, there will be more than one cane on the vine. In this case all but the strongest and best placed must be removed and this treated like the single cane in figures 36 and 37. Unfortunately the strongest is often not the best placed. In fact, if tying up during the summer has been neglected it is often the worst placed. The more vigorous the vine the more likely is the position of the canes to be defective. This is especially true of grafts on old vines, which should be treated like exceptionally vigorous vines during the second growing season. In these cases of neglected vines, the best canes are often lying flat on the ground. It will require all the ingenuity and skill of the pruner to get them into a more or less erect position, and at the best they will result in crooked, misshapen vines.

By removing the soil from around the base of the vine the cane can often be raised more easily and the bend will then be at least partially in the underground stem, where it is less harmful. In the worst cases it may be impossible to raise a cane. It is then necessary to cut all the canes back to the old wood and to develop a new cane the next year.

Even if the main cane has been tied up, the removal of the other canes, if they are numerous and large, makes many serious wounds at the collar of the vine, which in some cases weaken the vine considerably.

Third Summer Pruning.—During the third season, average well grown vines, such as those represented in figures 36 and 37, will produce their first considerable crop and develop the canes from which will be formed the first arms.

Figure 39 represents such a vine soon after the starting of the buds in spring. One vigorous shoot about three inches long has grown from the old wood and five fruit buds have started above on the cane. All the buds and shoots below the middle of the cane should be removed.

This will leave the four or five fruit buds and will give the vine the opportunity to produce eight or ten bunches of grapes. These buds will produce also at least four or five shoots. If the vine is very vigorous and the season favorable they may produce eight, ten or more.

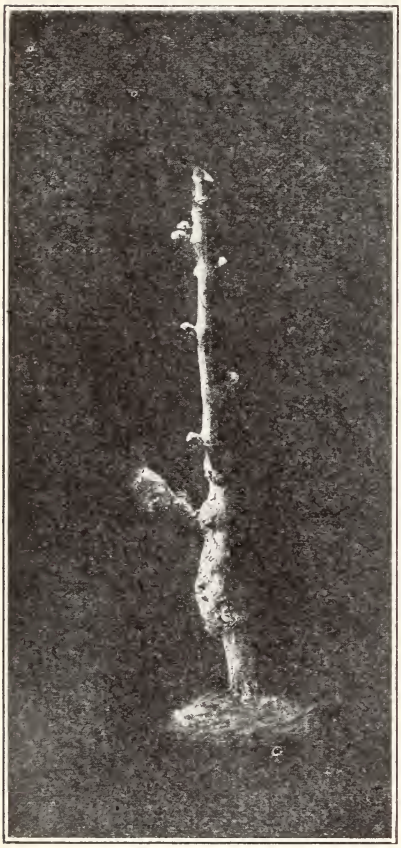


Fig. 39—Third spring, ready for disbudding.

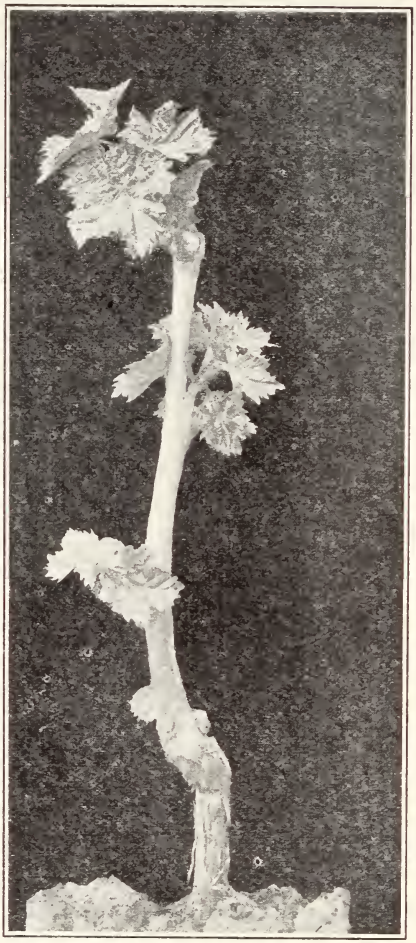


Fig. 40—Third spring, cane too short.

This figure will serve to illustrate how the height of the head can be modified later. When the five shoots grow, the height of the head will be determined at the next winter pruning by which of the corresponding canes are left as spurs. If the highest two canes are cut back to spurs and all others removed, the vine will be headed as high as

possible, as these two spurs form the two first arms which determine the length of the trunk. If the lowest two canes are chosen and all of the vine above them removed, the trunk will be made as low as possible. Intermediate heights can be obtained by using some other two adjacent canes and removing the rest. It is often advisable to leave some extra spurs lower than it is desired to head the vine and to remove these lower spurs the following winter after they have borne a crop. For example, the three or four upper canes might be left, if the vine is vigorous enough, and the lowest one or two of these removed at the next pruning. This, however, is not often necessary with properly handled vines and is objectionable because it makes large wounds in the trunk.

Figure 40 shows a vine of which the cane is too short. This was due to the accidental breaking off of the upper part of the cane. In this case it is best to remove all the buds and shoots but the uppermost two. Otherwise the vine may head out too low. Such a vine will usually make several shoots from each of the buds left, and while it will produce few grapes the current year, it will be in proper shape to produce a good crop the following year.

During this spring it will be necessary to sucker and remove low shoots at least once more. This can be done when the vines are hoed. If the vines grow vigorously the shoots should be pinched when they are eighteen to twenty-four inches long to protect them from the wind.

Fig. 41—Vineyard during the third summer.

Fig. 42—Crop at end of third season.

Fig. 43—Three-year-old vine ready for pruning.

Figure 41 shows a well grown vineyard towards the end of the third summer. The vines shown produced at the rate of five tons per acre, which may be considered about two-thirds of a full crop for full bearing vines of the variety, under the soil and climatic conditions of the vineyard. The crop of one of these vines left on the vine until after the fall of the leaves is shown in figure 42.

Third Winter Pruning.—At the end of the third season's growth the vine should have a straight, well developed trunk with a number of vigorous canes near the top from which to form the arms.

Figure 43 represents a well grown vine at this period. No shoots have been allowed to grow on the lower part of the trunk and the five buds allowed to grow above, have produced nine vigorous canes. The pruner should leave enough spurs to supply all the fruit buds that the vine can utilize. The number, size, and thickness of the canes show that the vine is very vigorous and can support a large crop. It will depend somewhat on the variety how many buds should be left. For a variety whose bunches average one pound, and which produces two bunches to the shoot, twelve fruit buds should give about twenty-four pounds, or about seven tons per acre, if the vines are planted 12 by 6 feet, as these were. The number of spurs will depend on their length. Six spurs of two buds each will give the required number, but as some of these canes are exceptionally vigorous they should be left a little longer, in which case a smaller number of spurs will suffice.

When the number and length of the spurs is decided on, the canes should be chosen which will leave these spurs in the most suitable position for forming arms. This position will depend on whether we want a vase-form or fan-shaped vine. In the first case, we choose those which will distribute the spurs most evenly and symmetrically on all sides, avoiding any which cross or point downwards.

In the second case, we choose only those canes which run in the

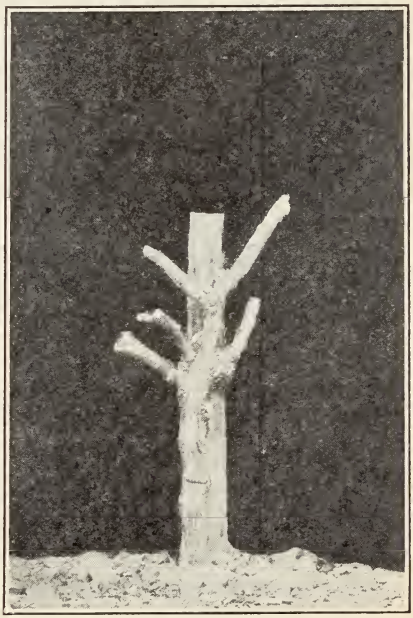
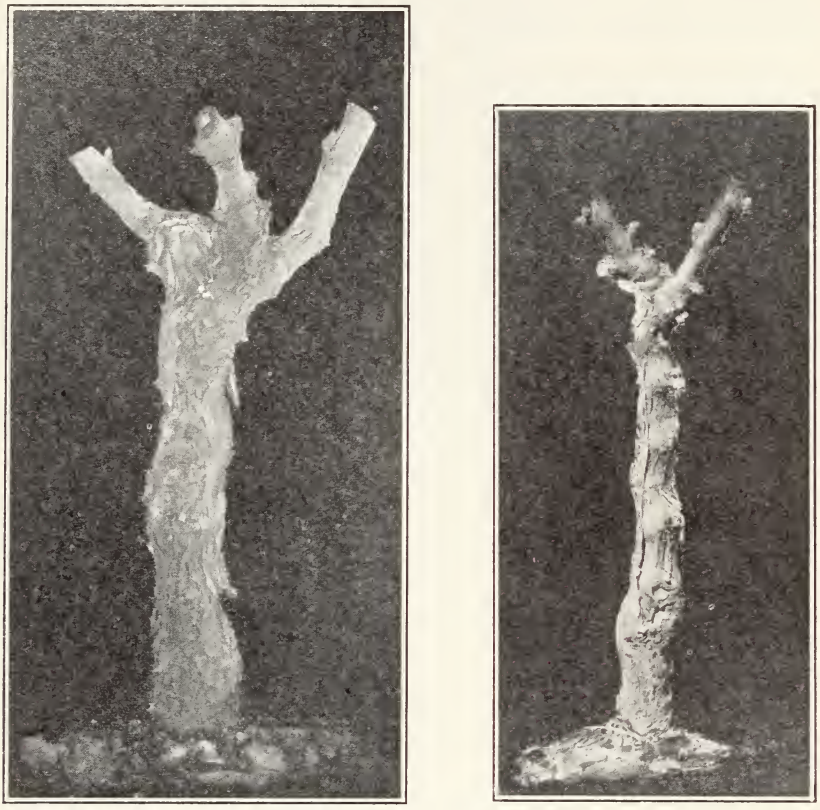


Fig. 44—Vine of Fig. 43 after pruning for vase-formed head.

direction of the trellis, avoiding canes which stick out between the rows. Downward pointing canes may be used in this case.

Figure 44 shows the vine after pruning for a vase-formed head. The pruner has used two of the strongest canes to form two three-bud spurs and three of medium vigor to form three two-bud spurs. The head is of good shape, though some of the spurs are a little too low.



A B

Fig. 45—Three-year-old vines: A, pruned for a vase-formed, and B, for a fan-shaped head.

One, two, or three of these can be removed at the following winter pruning, and the permanent arms and head of the vine formed from canes which develop on the two highest spurs. If the vine were too high the head could be developed the next year from the three lowest spurs and the upper part removed.

Figure 45 shows vines of the same age of practically perfect shape. Less spurs have been left because the vines were less vigorous. It is

easier to properly shape vines which make only a moderate growth during the first three seasons. On the other hand, very vigorous vines can finally be brought into practically perfect shape and the somewhat larger and more numerous wounds necessary are more easily healed by a vigorous vine.

Pruning after the Third Winter.—For the pruner who understands the pruning of young vines and has brought them to approximately the form represented in figures 44 and 45, the subsequent winter pruning is very simple. It involves, however, one new idea—the distinction between fruit and sterile wood.

Up to the third winter pruning, this distinction is not necessary; first, because practically all the wood is fruit wood, and second, because the necessity of forming the vine controls the choice of wood. From this time on, however, this distinction must be carefully made. At each winter pruning a number of spurs of fruit wood must be left to produce the crop to be expected from the size and vigor of the vine. Besides these fruit spurs, it may be necessary to leave spurs of sterile wood to permit of increasing the number of fruit spurs the following year.

This will be made clear by comparing figures 45 A and 46. Figure 45 A shows a vine at the third winter pruning with two fruit spurs of two buds each and one fruit spur of one bud—five fruit buds in all.

If these five fruit buds all produce vigorous shoots during the following summer, they will supply five canes of fruit wood which can be used to form five fruit spurs at the following winter pruning, which will be about the normal increase necessary. Some of these fruit buds, however, may produce weak shoots or shoots so badly placed that they would spoil the shape of the head if used for spurs. Other shoots, however, will be produced from base, secondary and adventitious buds which, while less fruitful, can be used to form spurs for the starting of new arms.

Figure 46 shows a vine after the fourth winter pruning which had developed from a vine similar to that shown in figure 45 A. From the three fruit spurs left the previous year four canes have been chosen for the fruit spurs of this year. The old spur on the left has furnished two new spurs and the two old spurs at the right each one new spur. The pruner, judging that the vine is sufficiently vigorous to stand more wood, has formed two spurs from water sprouts which, while not likely to produce much fruit the first season, will supply fruit wood for the following year. The result is a very well shaped vine with six almost perfectly balanced spurs. These spurs will de-

velop into permanent arms, some of them furnishing finally two or three.

Fig. 46—Four-year-old vine pruned for vase-formed head.

Figure 47 shows a high headed vine of the same age. It has five spurs, of which four are fruit spurs and one a spur of sterile wood left to shape the vine. The two more or less horizontal spurs on the right will bear fruit the following autumn and will be removed entirely at the following winter pruning, as they are badly placed. The arms of the vine will then be developed from the three upright spurs, which are excellently placed.

Each year thereafter the same process must be followed. First, enough fruit spurs, as well placed as possible, must be left to produce the crop. Second, on most vines, supplementary spurs of sterile wood must be left to supply more arms where they are needed, and finally, when the full complement of arms has developed, to supply new arms to replace those which have become too long or are otherwise defective.

Fig. 47—Four-year-old vine pruned for high vase-formed head.

Figure 48 shows a fully formed Carignane vine with six well placed and well shaped arms. Such a vine will probably not need a larger number of arms, but care must be taken that none of those it has become too long. This is the stage at which provision should be made for replacing arms when they threaten to become too long. The arm on the left will in two or three years extend too far from the head and will be in danger of being broken off. This year, therefore, a replacing spur should be left as near the head of the vine as possible. Such a spur can be formed from the upright water sprout which can be seen growing out of the three-year-old wood of the arm. One or two fruit spurs can be formed from the two fruit canes above this. After these fruit spurs have borne their crop, the arm can be cut back to the replacing spur, which by that time will have furnished the necessary fruit wood. This cutting back to shorten or replace the arm may be done at the following or some subsequent winter pruning, according to the way in which the growth develops.

Sometimes it is difficult to find water sprouts in suitable positions for replacing spurs. This may be due to weakness of the vines, which are able only to develop shoots on the fruit spurs and have no surplus vigor to force out dormant buds on the older wood. This difficulty can be met by shorter pruning. If an arm is too long, and at the

same time weak, it should be pruned to extra short spurs. This will tend to force water sprouts to start from the older wood near the base of the arm.

Fig. 48—Seven-year-old Carignane vine with fully developed vase-formed head.

The absence of water sprouts at the winter pruning may also be due to their having been removed during the summer. When water sprouts are removed the need of replacing wood should always be kept in mind, and one vigorous, well placed water sprout left near the base of every long arm.

Figure 49 shows an old Carignane vine where this periodical shortening and replacing of the arms has been done systematically. The near side of the vine is nearly bare of arms. At the previous winter pruning a replacing spur was left right in the head of the vine on

Fig. 49—Nine-year-old Carignane vine with well formed arms.

the near side. This produced a cane which is utilized this year as a fruit spur and which will develop into an arm. Another similar arm is being developed this year from a water sprout growing out of the old wood at the left.

Figure 50 shows an old vineyard in which the vines have been kept in good form, though the heads are a little too low.

Fan-shaped Vines.—With headed vines, the treatment up to the stage represented by figures 36, 37, and 38 is the same except for the variations in the height of the head. At the third winter pruning, however, the formation of the head commences, and the pruner determines whether it shall be *vase-formed* or *fan-shaped.* The production of a vase-formed head has already been described.

At the third winter pruning, the vine should be pruned to two spurs, as shown in figure 45 B. More vigorous vines should *not* be given more spurs, as in figures 44 and 45 A, but the spurs should be made longer, with four, five, or even six eyes in some cases. This is in order to obtain some fruit, which might not be obtained from long pruning varieties by leaving many spurs. With extremely vigorous

Fig. 50—Vineyard of 15-year-old Carignane vines with low medium trunks and vase-formed heads.

vines one fruit cane may be left at this pruning. The wires of the trellis should be put up this year, if this has not already been done.

Figures 51 and 52 illustrate the second step in the production of a fan-shaped head. This form of head is used only for trellised vines and long-pruned varieties. The formation of the head and the management of the fruit canes are therefore conveniently discussed together.

By comparing the pruned vine, figure 52, with the unpruned, figure 51, the method of pruning will be made clear.[2] The unpruned vine shows two arms, the spurs of the previous year, from one of which have grown three vigorous canes and from the other two

[2] By mistake the photograph from which figure 52 was made was reversed, so that the right side of figure 51 corresponds to the left side of figure 52.

somewhat less vigorous. The pruned vine shows a complete unit, that is, a fruit cane with its accompanying renewal spur on the vigorous side and a spur for the production of fruit wood for the following year on the other side. If the vine had been more vigorous two complete units would have been left and one or two extra spurs.

Fig. 51—Before pruning.

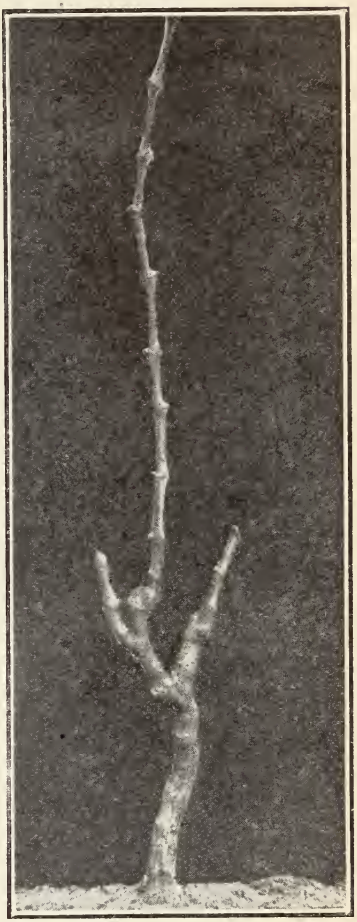


Fig. 52—After pruning.

As the form of the vine is determined by the renewal spurs, special attention should be paid to their position. In this case, the middle cane on one arm and the lower cane on the other have been used for renewal spurs. This brings them both to the same height above the ground and determines the place of the permanent arms. The next year each of these spurs will furnish a fruit cane and one or two

renewal spurs. The arms will thus in two or three years be increased to four, or, with very large vines, to six. These spurs should be chosen as nearly as possible in the plane of the trellis, that is, they should not project out sideways. Figures 23 and 54 show vines of this kind of full size and in full bearing.

The fruit canes also should be as nearly as possible in the direction of the trellis, though this is not so important, as they can be bent over to the wire when tied up, and in any case they are removed the next year.

Figure 53 shows a trellised vineyard of Sultanina. The vines are somewhat irregular and proper care has not been exercised in the choice of fruit canes and renewal spurs. It is worse than useless to

Fig. 53—Trellised vineyard of Sultanina. Pruning defective.

use water sprouts or suckers for fruit canes, and care in the selection of renewal spurs would have prevented the awkward, ungainly arms. A vineyard such as the one shown will not only not bear so large a crop but will cost twice as much to prune as one in which the vines are kept in the proper shape.

Figure 54 shows the crop on a trellised Sultanina pruned by this system. It shows the regular open distribution of the grapes, all at about the same distance from the ground. Such grapes develop and ripen equally and perfectly.

Double-headed Vines.—Some growers attempt to arrange the arms of their vines in two stages, one above the other, forming double-headed or two-crowned vines. The method is applied to both vase-

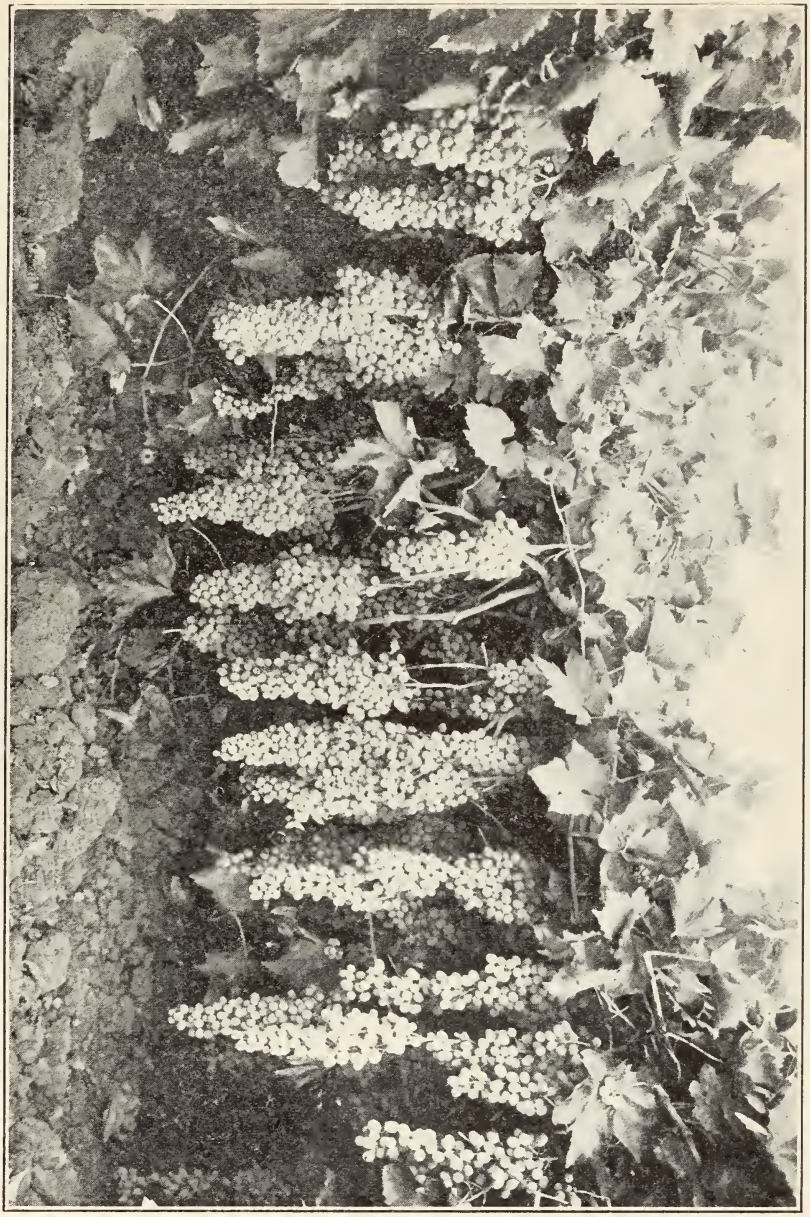


Fig. 54—Trellised Sultanina vine.

formed and trellised vines. It is open to the same criticisms as the vertical cordon, the chief of which is that it cannot be maintained permanently. The lower head or ring of arms finally becomes weak and fails to produce wood.

It is easier to maintain in trellised vineyards and has some advantages, the chief of which is that it makes it easier to keep the vine in the single plane and to prevent arms getting into the inter-rows. Figure 55 illustrates a method of starting a double crown in a trellised vineyard. The vine represented is four or five years old. Finally,

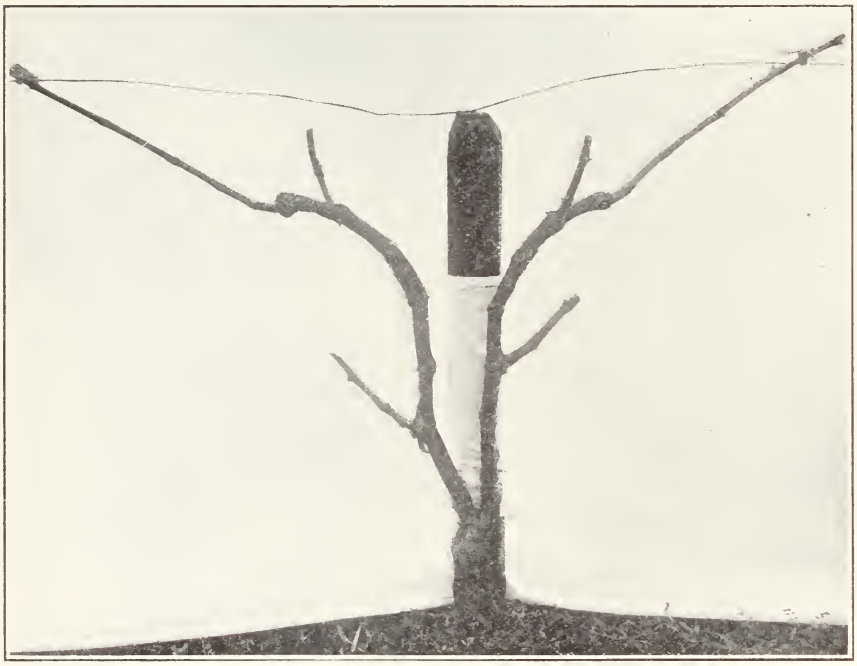


Fig. 55—Trellised vine with double head.

it will have two full units on each side. The double trunk is not necessary and is, in fact, a disadvantage, as one trunk has a tendency to grow at the expense of the other.

Vertical and Bowed Canes.—Figures 56 and 22 A show a long-pruned vine in which the fruit canes have been tied vertically to a tall stake. This is a method used commonly in many vineyards. The unit of pruning is the same as in the method just described. consisting of a fruit cane and a renewal spur. The framework of the vine consists of a trunk of medium height, with a vase-formed head consisting of three or four arms. The defects of this system have been pointed out on pages 60, 61.

It is used with fair success with seedless Sultanas and with some wine grapes such as Colombar, Semillon, Cabernet, and Reisling, in

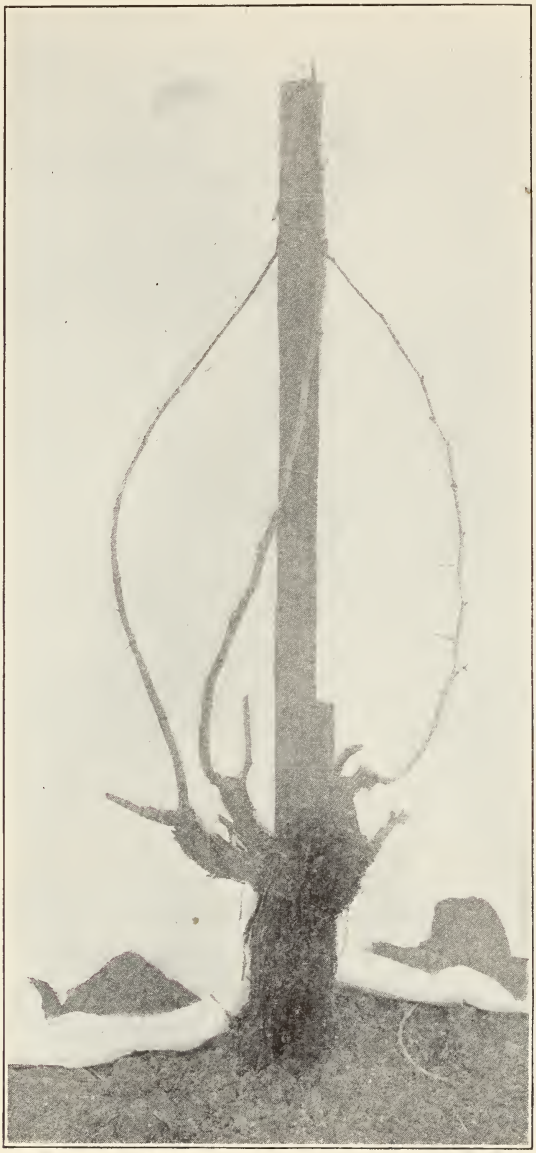


Fig. 56—Vine with vertical canes.

the hands of skillful pruners. The results with Sultanina are very unsatisfactory. Figure 57 shows a vineyard of this variety.

By this method, on most of the vines, the fruit canes start from high up near the middle of the stake, and are therefore too short for the best results. The canes which start from low down are in most cases suckers, and therefore of little value for fruit bearing.

Figure 22 B shows a vine with bowed canes. The method of pruning is exactly the same as in the method just described. The bowing of the canes, however, overcomes some of the defects of that method. It is used regularly in many wine grape vineyards of the cooler regions. It is unsuited for very vigorous vines in rich soil.

Vertical Cordons.—In head pruning, the treatment of young vines up to the second or third winter pruning is identical for all systems.

Fig. 57—Vineyard with vertical fruit canes. Pruning defective.

In cordon pruning the treatment for the first and second is also the same. That is, the vine is cut back to two buds near the level of the ground until a cane sufficiently long to serve for the formation of the trunk is obtained.

In the vertical cordon the trunk is three to four feet long instead of one to two, as in head pruning. This makes it necessary to have a longer and more vigorous cane to start with. It may require a year longer to obtain this. That is to say, at the end of the second season's growth many vines will not have a single cane sufficiently developed to give the necessary three and one-half feet of well ripened wood and properly developed buds. At the second winter pruning, therefore, it will often be necessary to cut the vine back to two buds, as at the first winter pruning.

Finally, a cane of the required length will be obtained. The vine is then formed as already described for the second winter pruning of headed vines, except that the cane is left longer. This cane is then

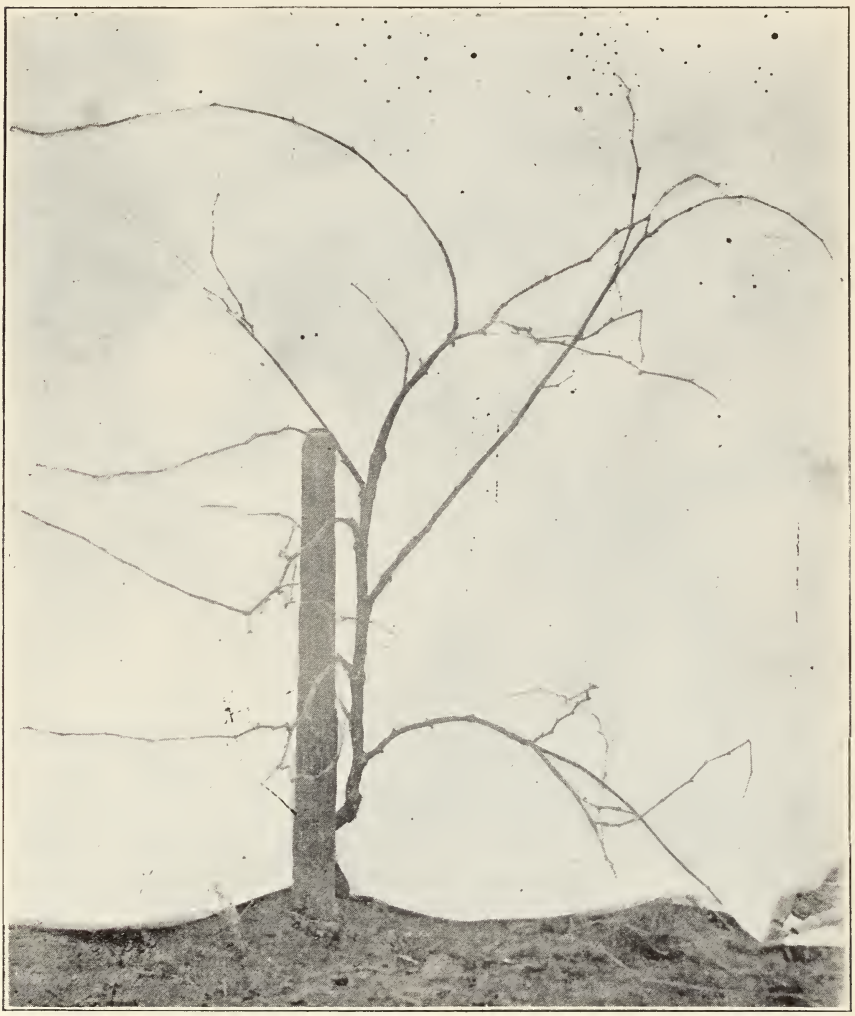


Fig. 58—Vertical cordon, young vine unpruned.

tied to the stake and at the end of the following year we have a vine like that shown in figure 58.

When such a vine is pruned, spurs are left at intervals along the trunk, as shown in figure 59. Each of these spurs is a fruit spur and

is also the commencement of an arm. The future treatment of these arms is the same as that of the arms in head pruning.

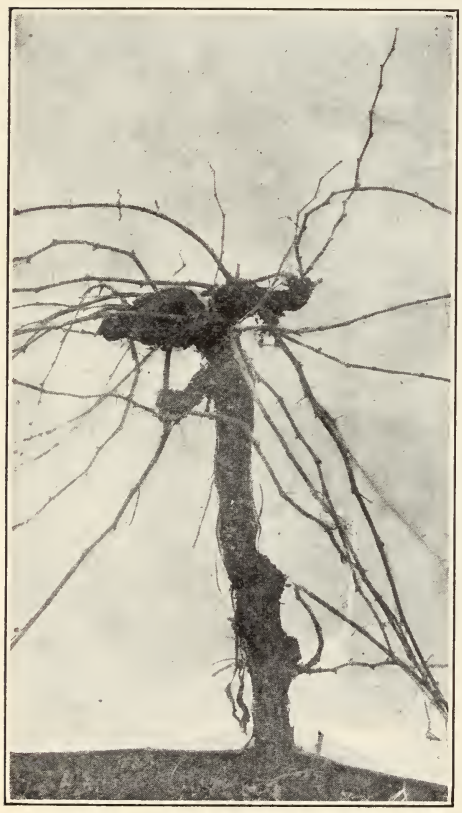
Figure 60 shows a six-year-old Emperor vineyard pruned in this way. It is in excellent condition, but cannot long be kept so. As the

Fig. 59—Vertical cordon, young vine pruned.

vines become older it becomes more and more difficult to obtain satisfactory growth on the lower spurs. Finally, the whole growth of the vine is concentrated at the top and instead of a cordon we simply have an inconveniently high-headed vine.

Figures 61 and 62 show an old Emperor vine before and after pruning, which was started as a vertical cordon, but has finally developed into the form described. Such a vine has none of the advantages of a cordon and is inferior to a headed vine of moderate height.

Fig. 60—Vineyard of vertical cordons.



Figs. 61 and 62—Ultimate form of a vertical cordon, pruned and unpruned, defective.

Figure 63 shows a double vertical cordon, which has no advantage over the single and all its disadvantages. It is, moreover, more troublesome and costly to prune and the bunches are more difficult to

Fig. 63—Vertical cordon with double trunk defective.

gather without injury. More than two stems are sometimes grown, which increases these difficulties and defects.

Horizontal Cordons.—During the first two or three years, vines which are to be given the form of horizontal cordons are treated ex-

actly as for vertical cordons, that is, they are pruned back to two buds each winter and the growth forced by disbudding into a single cane during the summer.

As soon as a well ripened cane of the required length is obtained, it is tied to a wire stretched horizontally along the row at from fifteen to twenty-four inches from the ground.

For this system of pruning, the rows should be twelve to fourteen feet apart and the vines six, seven, or eight feet apart in the rows. As the cordon or trunk of each vine should reach the next vine, it will have to be six to eight feet long. The best shape is obtained when the trunk is all formed one year from a single cane. It is necessary, however, sometimes to take two years for the formation of the trunk. In any case, the cane first tied down should reach at least half way to the next vine. The following year a new cane from the end of this should be used to complete the full length of the trunk.

In attaching the cane to the wire, it must be bent over in a gentle curve and care taken not to break or injure it. The proper form of the bend is shown in figures 25 and 64, and by the vine at the left side of figure 65. Sharp bends such as those shown by the vines in figure 66 and on the right of figure 65 should be avoided.

The cane should be placed on top of the wire, but should not be twisted around it. The end should be tied firmly and the rest of the cane supported by strings tied loosely in order to avoid girdling when the cane grows.

In the following spring, most of the buds on a good cane will start. If the cane is short jointed, some of the shoots should be removed and only those shoots allowed to develop which are conveniently situated for permanent arms. If the vines are to be short pruned, the arms should be developed every eight to twelve inches from a few inches beyond the bend to the extreme end. For long pruning, the arms should be farther apart, twelve to twenty inches. Shoots starting from the top of the cane and growing vertically upwards are to be preferred.

As the shoots develop, the strongest should be pinched repeatedly, if necessary. This will tend to force the growth of the weaker shoots and to equalize the vigor of all. At the end of the season, there should be from five to ten canes growing on each cordon of full length. These canes are then pruned back to two or three buds, or a little longer for long-pruned varieties.

During the following spring and summer, the vines should be carefully suckered and unnecessary water sprouts removed. Any shoots coming from the lower side of the cordon should be removed early to

strengthen the growth in the shoots on the upper side. Neglect of this precaution is shown by the vines in figures 66 and 67. Such vines are apt to become dry or decayed on the upper side. At the end of this year, which should be the fourth or fifth from planting at the latest, the cordon will be fully formed and the final style of pruning can be applied. A short-pruned cordon vine is shown in figure 25. The arms and spurs are a little too numerous and too close together. If this vine required the number of buds shown it would have been

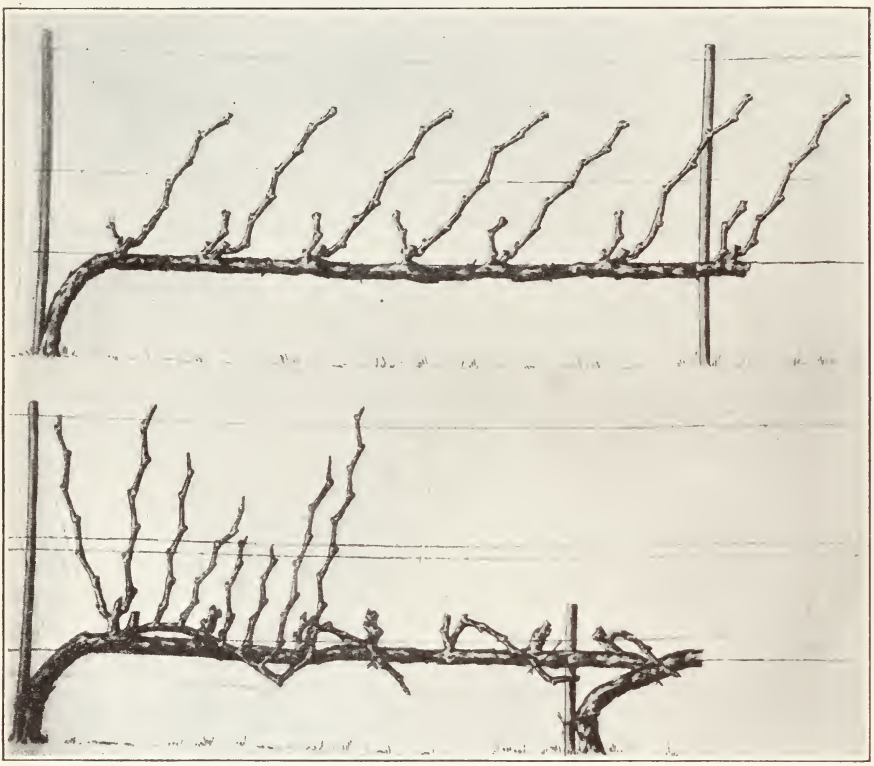


Fig. 64—Unilateral horizontal cordon with half-long pruning.

better to have left the fruit spurs longer and to have left fewer and shorter wood spurs.

The upper vine of figure 64 shows a cordon pruned half long. This is an excellent system for Malaga, Emperor, and Cornichon when growing in very fertile soil. It gives the half-long fruit canes, which these varieties need to produce good crops. The fruit canes may be attached to a wire twelve or fifteen inches above the cordon or bent down and tied to the cordon itself, as in the lower vine of the figure.

The first method is the more convenient, but the second is necessary where there is difficulty in obtaining satisfactory growth from the renewal spurs. When the fruit canes are tied down, as indicated in the lower vine, renewal spurs may not be needed, as vigorous shoots will usually be obtained from the lower buds of the fruit canes.

Figure 65 shows a well formed cordon in full bearing. The vine is Semillon grafted on St. George and is pruned short. The Semillon is a variety which usually requires long pruning, but the combined effects of grafting on resistant stock and horizontal cordon pruning

Fig. 65—Unilateral horizontal cordon; var. Semillon.

have increased its fertility so that a sufficient crop is obtained from short spurs. If such a vine were pruned long it would quickly exhaust itself, except in the richest soil.

Figure 66 shows an old Semillon cordon with several defects. The bend is too short and the growth of cane is all from the lower side. The half-long canes in this case will not exhaust the vine because most of them are water sprout canes and will bear little.

Figure 67 gives a view of the vineyard in which the vine of figure 66 grew. Little or no benefit is obtained from cordons handled in this way.

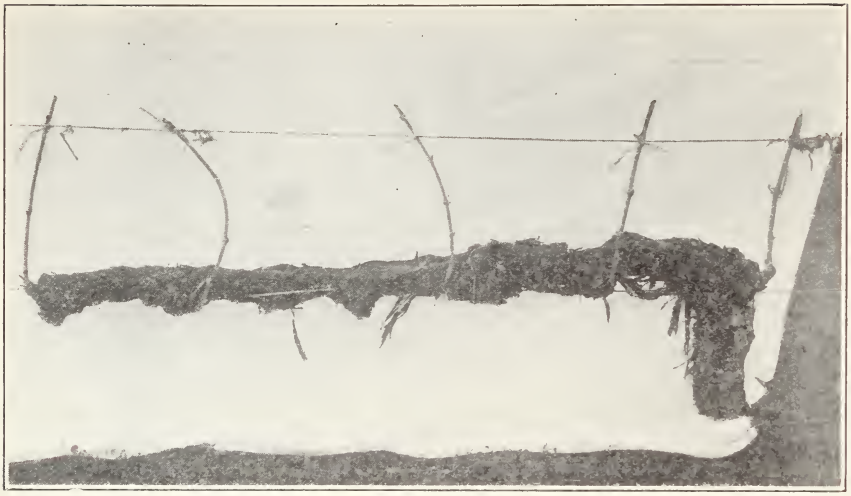


Fig. 66—Defective cordon.

Fig. 67—Vineyard of horizontal cordons, unilateral. Defective pruning.

Figure 68 shows a vineyard of Colombar, illustrating a bilateral cordon. With vines at the same distance apart, each cordon is only half the length of a unilateral cordon. It is a little easier to establish but more difficult to keep in good form. One branch tends to become stronger than the other and in windy situations the branch growing towards the prevailing wind is more subject to injury.

Renovation of Imperfect or Misshapen Vines.—The pruner with definite ideas who properly handles his vines from the beginning can, in most cases, bring them into the required shape with comparative ease. Often, perhaps usually, he has to deal with vines which have some more or less serious fault. They

Fig. 68—Vineyard of horizontal cordons, bilateral.

may be misshapen owing to defective pruning or otherwise imperfect owing to mechanical injuries, or as the result of frost, fungi, or insect pests.

If the vines are young, the defects can often be overcome and the vine given a proper form very easily.

Figure 69 shows a vine at the end of the year after tying up. Most of the growth has gone into a cane near the base and the growth from the top buds has been poor. This condition is likely to occur when a small or imperfectly ripened cane has been used from which to attempt to form a trunk. There are three possible ways of pruning this vine. First, the two small canes at the top can be cut back to form spurs and all other canes removed. This will give a vine with the head at the right height, but all the best wood has been cut off. It will result in four large wounds on the trunk and the vine will require a great deal of attention during the following growing season, as water sprouts will be numerous and vigorous on the lower and healthier portion

of the vine. Moreover, the attempt to force the growth into the weak top will delay the development of the vine and even result in a permanently weak top.

Second, two or three of the canes about the middle of the trunk can be cut back to spurs and the rest removed, including the whole top and the largest cane at the bottom. This will give a healthier and stronger vine, but the head will be too low.

Third, a new trunk can be started from the strong cane near the bottom and the whole growth above removed, as shown in figure 70. This preserves the strongest cane, on which most of the energies of the vine was expended during

Fig. 69—Young vine with imperfect top.

the preceding season, only one large wound is made and all the defective and dwarfed parts of the vine are removed. The formation of the head is deferred one year, but the vine will have a stronger, healthier and better formed trunk and will probably bear as much the following year as if pruned in either of the other ways.

In any vineyard, many of the vines, in some, most of them, will show imperfections or abnormalities of a similar nature. No general rule of treatment can be given; each vine is a separate problem. The pruner should endeavor to choose that method in each case which will finally and most quickly give him a vine of the desired form while utilizing as much as practicable the best and most vigorous parts of the vine and making as few and as small wounds as possible.

As the vines become older, it becomes increasingly difficult to overcome defects of formation. The disadvantage of a low head may be in part avoided by gradually lengthening the arms and giving them a more vertical direction. An ill-formed head may be improved by removing badly placed arms and developing new arms where needed.

The trunks of many old vines are so defective that little improvement can be obtained by these means. It is possible and occasionally profitable to completely renew the trunks of such vines. This can be done by developing a new trunk from a strong cane originating at or below the surface of the ground and then cutting away the old trunk.

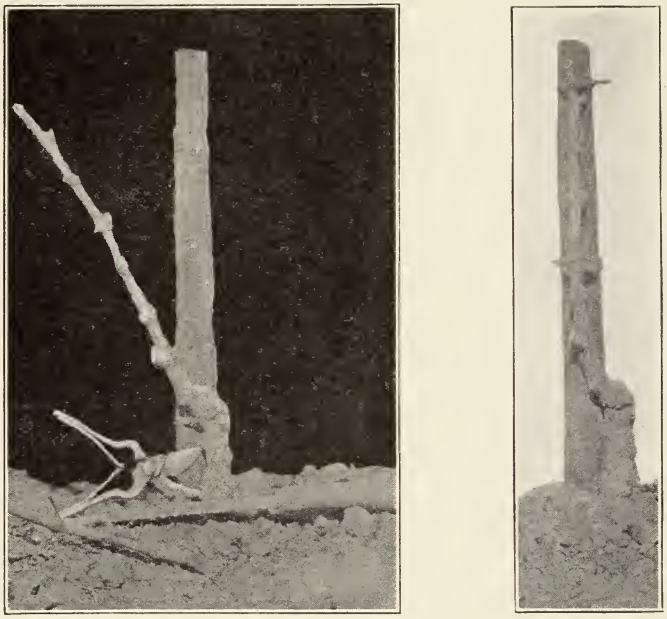


Fig. 70—Pruning to renew imperfect top of vine of Fig. 69.

This method has the same defect as the grafting of old vines. It leaves a large wound where the old stump was removed, a wound which can never heal and which finally allows the entrance of wood-rot fungi. Such renewed vines, however, may last as long as if the old decayed trunk had been left or longer. They will also be more fruitful and easier to handle properly. The change can be made without the loss of a crop, as occurs in grafting. If the stumps are large, the expense of sawing them off is considerable.

Choice of a System.—In choosing a system, we must consider carefully the characteristics of the particular variety we are growing. A variety which bears only on the upper buds must be pruned "long," that is, must be given fruit canes. It should be noted that many varieties, such as Petite Sirah, which will bear with short pruning when grafted on resistant roots require fruit canes when growing on their own roots. In general, grafted vines require shorter pruning than ungrafted. If pruned the same, the grafted vines may

overbear and quickly exhaust themselves. This seems to be the principal reason for the frequent failure of Muscat vines grafted on resistant stock. The cultural conditions also affect the vine in this respect. Vines made vigorous by rich soil, abundant moisture, and thorough cultivation require longer pruning than weaker vines of the same variety.

The normal size of the bunch is also of importance. This size will vary from one-quarter of a pound to 2 or 3 pounds. It is difficult to obtain a full crop from a variety whose bunches are very small without the use of fruit canes. Spurs will not furnish enough fruit buds without crowding them inconveniently. On the other hand, some shipping grapes may bear larger crops when pruned long, but the bunches and berries may be too small for the best quality.

The possibilities of development vary much with different varieties. A Mission or Flame Tokay may be made to cover a quarter of an acre and develop a trunk four or five feet in circumference. A Zinfandel vine under the same conditions would not reach a tenth of this size in the same time. Vines in a rich valley soil will grow much larger than on a poor hillside. The size and shape of the trunk must be modified accordingly and adapted to the available room or number of vines to the acre.

The shape of the vine must be such as to protect it as much as possible from various unfavorable conditions. A variety susceptible to oidium, like the Carignane, must be pruned so that the fruit and foliage are not unduly massed together. Free exposure to light and air are a great protection in this respect. The same is true for varieties like the Muscat, which have a tendency to "coulure" if the blossoms are too moist or shaded. In frosty locations, a high trunk will be a protection, as the air is always colder close to the ground.

The qualities required in the crop also influence our choice of a pruning system. With wine grapes, even, perfect ripening and full flavor are desirable. These are obtained best by having the grapes at a uniform height from the ground and as near to it as possible. The same qualities are desirable in raisin grapes, with the addition of large size of the berries. With shipping grapes, the size and perfection of the berries and bunches are the most essential characteristics. The vine, therefore, should be so formed that each bunch hangs clear, free from injurious contact with canes or soil and equally exposed to light and air.

The maximum returns in crop depend on the early bearing of young vines, the regularity of bearing of mature vines and the longevity of the vineyard. These are insured by careful attention to all the details of pruning, but are possible only when the vines are given a suitable form.

The running expenses of a vineyard depend in a great measure on the style of pruning adopted. Vines of suitable form are cultivated, pruned and the crop gathered easily and cheaply. This depends also both on the form of vine adopted and on care in details.

It is impossible, therefore, to state for any particular variety or any particular location the best style of pruning to be adopted. All that can be done is to give the general characteristics of the variety and to indicate how these may be modified by grafting, soil or climatic or other conditions.

The most important characteristic of the variety in making a choice of a pruning system is whether it normally or usually requires long, half-long, or long pruning. With this idea, the principal grapes grown in California, together

with all those grown at the Experiment Station on which data exist, have been divided into five groups in the following list:

1. *Varieties which require long pruning under all conditions.*—Clairette blanche, Corinth white and black, Seedless Sultana, Sultanina white (Thompson's Seedless) and rose.

2. *Varieties which usually require long pruning.*—Bastardo, Boal de Madeira, Chardonay, Chauché gris and noir, Colombar, Crabbe's Black Burgundy, Durif, Gamais, Kleinberger, Luglienga, Marsanne, Marzemino, Merlot, Meunier, Muscadelle de Bordelais, Nebbiolo, Pagadebito, Peverella, Pinots, Rieslings, Robin noir, Ruländer, Sauvignon blanc, Semillon, Serine, Petite Sirah, Slancamenca, Steinschiller, Tinta Cao, Tinta Madeira, Trousseau, Verdelho, Petit Verdot, Wälchriesling.

3. *Varieties which usually require short pruning.*—Aleatico, Aligoté, Aspiran, Bakator, Bouschets, Blaue Elbe, Beba, Bonarda, Barbarossa, Catarattu, Charbono, Chasselas, Freisa, Frontignan, Furmint, Grand noir, Grosseblaue, Green Hungarian, Malmsey, Mantuo, Monica, Mission, Moscatello fino, Mourisco branco, Mourisco preto, Negro amaro, Palomino, Pedro Zumbon, Perruno, Pizzutello di Roma, Black Prince, West's White Prolific, Quagliano, Rodites, Rozaki, Tinta Amarella, Vernaccia bianca, Vernaccia Sarda.

4. *Varieties which require short pruning under all conditions.*—Aramon, Burger, Chardonay, Chauché gris and noir, Colombar, Crabbe's Black Burgundy, Durif, Black Morocco, Mourastel, Muscat of Alexander, Napoleon, Picpoule blanc and noir, Flame Tokay, Ugni blanc, Verdal, Zinfandel.

5. *Varieties of Table Grapes which usually require half-long or cordon pruning.*—Almeria (Ohanez), Bellino, Bermestia bianca and violacea, Cipro nero, Dattier de Beirut, Cornichon, Emperor, Black Ferrara, Malaga, Olivette de Cadenet, Pis-de-Chevre blanc, Schiradzouli, Zabalkanski.

These lists must not be taken as indicating absolutely for all cases how these varieties are to be pruned. They simply indicate their natural tendencies. Certain methods and conditions tend to make vines more fruitful. Where these occur, shorter pruning than is indicated may be advisable. On the other hand, other methods and conditions tend to make the vines vigorous at the expense of fruitfulness. Where these occur, longer pruning may be advisable.

The more usual factors which tend towards *fruitfulness* are:

Grafting on resistant vines, especially on certain varieties such as those of Riparia and Berlandieri;

Old age of the vines;

Mechanical or other injuries to any part of the vine;

Large development of the trunk, as in the cordon systems.

The more usual factors which tend towards *vigor* at the expense of fruitfulness are:

Rich soil, especially large amounts of humus and nitrogen;

Youth of the vines;

Excessive irrigation or rainfall (within limits).

In deciding what system of pruning to adopt, all these factors, together with the nature of the vine and the uses to which the fruit is to be put, must be considered. It is best when the vineyard is started to err on the side of short pruning. While this may diminish slightly the first one or two crops, the vines will gain in vigor and the loss will be made up in subsequent crops.

If the style of pruning adopted results in excessive vigor of the vines, it should be gradually changed in the direction of longer pruning with the object of utilizing this vigor in the production of crop.

This change should be gradual, or the risk is run of injuring the vitality of the vines by one or two excessively heavy crops. Finally, each year the condition of the individual vine should determine the kind of pruning to be adopted. If the vine appears weak, from whatever cause, it should be pruned shorter or given less spurs or fruit canes than the year before. On the contrary, if it appears unnecessarily vigorous, more or longer spurs or fruit canes should be left. Every vine should be judged by itself. It is not possible to give more than general directions for the pruning of the whole vineyard. It cannot be well pruned unless the men who do the actual pruning are capable of using sufficient judgment to properly modify their methods for each individual vine.